Aerobic Bacteria Involved in the Retting of Jute

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Jute, Corchorus capsularis, is the most important cash crop of Pakistan. Most of the foreign exchange earned comes from the export of jute. For this reason jute is popularly called the "golden fiber" of Pakistan.

A very important step in the jute industry is retting. During this process, some microorganisms decompose pectins of jute bark and the intervening tissues disintegrate. The pectins are divided into three groups: (a) propectins, (b) pectins, and (c) pectic acids. The enzyme propectinase is known to hydrolyse propectin to pectin which is broken down by the enzyme pectinase to galacturonic acid and residues. Microorganisms are capable of producing one or all of these enzymes that break down the pectic substances (Chaudhury, 1951).

Adati and Yoshimara (1939) isolated two species of aerobic bacteria whose actions on jute stem were not studied. Katagiri and Makahama (1940) isolated an anaerobic bacillus, Bacillus corchorus n. sp., which retted jute stems. Patel and Ghosh (1943) reported accelerating effects of different salts on jute retting. Baruah and Baruah (1947) reported actions of extracted enzymes from some bacteria on jute. The bacterial enzymes were reported to have caused the maceration of the tissues by attacking the middle lamella and breaking pectin. The enzymes could ret jute, coconut, and ramie within a period which varied from 1 to 7 days. Bacillus comestii Rossii, an aerobic sporeforming rod has been utilized industrially in Italy, France, and Germany for retting flax and hemp. Kayser and Delavel (1920) isolated five species of aerobic bacteria and one species of anaerobic bacteria which were capable of retting flax and hemp. Hauman (1902) isolated some bacteria from retted flax stems. Patel and Ghosh (1943) also isolated one rod-shaped and one oval bacteria from retted jute stem. Debsharma (1946) isolated some seven species of aerobic bacteria of which Bacillus subtilis, Bacillus mesentericus, and Bacillus macraeans showed retting ability. Amiruddin (1951) isolated five aerobes of which none was found to ret.

This investigation was carried over to detect aerobic jute retting bacteria.

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Materials and Methods

For the detection of the retting ability of such bacteria, sterile jute-stem-tubes were prepared by introducing into test tubes pieces of jute stem 2½ in. in length and enough distilled water to just cover them, and then autoclaving. The tubes were inoculated separately with different pure aerobic bacteria isolated from retted jute obtained from different regions of East Pakistan. These inoculated jute tubes were then left at room temperature for days to ascertain the ability of the bacteria to ret jute. If any stem in the inoculated tube was found retted, that is, the pectins of the bark of the stem decomposed and the intervening tissue disintegrated, the bacteria concerned were taken as retters.

Results

Of the different sporeforming aerobic bacteria identified as Bacillus polymyxa, Bacillus subtilis, Bacillus cereus, Bacillus sphaericus, Bacillus lentus, and Bacillus putrificus, the only bacterium found to ret jute was Bacillus polymyxa. This bacterium was isolated from a sample of jute retted for 5 days that had been collected from a ditch at the village Gopalpur, Pohibbi, Bogra, East Pakistan.

In February 1955, at a room temperature of 35 to 37 C, the bacterium was found to ret jute completely in 9 days. The retting behavior was as follows. No change was seen on the stem one day after inoculation. On the 2nd day, slight bubbling occurred in the water of the tube. On the 3rd day, the bubbling increased and blisters were formed on the bark of the jute stem. From the 5th day on, bubbling continued to decrease with the blisters undisturbed until the 9th day when no bubbling could be seen; the jute was completely retted and showed the separation of the golden fibers.

Cultural and physiological characteristics of the bacterium, the retter.

Spores: Ellipsoidal, 0.9 to 1.0 μ by 1.0 to 1.5 μ, subterminal, wall thick (figure 1A).

Sporangia: Swollen, elavate (figure 1A).

Rod: 0.4 to 0.6 μ by 1 to 2.5 μ, occurring singly, motile with peritrichous flagella, gram positive (figure 1B).

Hydrolysis of gelatin: Slow liquefaction taking 4 to 5 days.
Agar colonies: Moderate growth, whitish, lobed, spreading over entire plate.

Agar slant: Moderate growth, indistinct, whitish. On glucose agar, growth much heavier, raised, gummy, and formation of gas.

Nutrient broth: Granular turbidity, slimy sediment, pH 6.8.

Litmus milk: Acid curd produced, litmus changed.

Potato slant: Growth abundant, whitish, potato decomposed with formation of gas.

Nitrate medium: Nitrate reduced to nitrite.

Starch hydrolysis: Hydrolyzed but dextrin not detected.

Fermentation: Acid and gas from glucose, galactose, mannose, maltose, sucrose, lactose, dextrin, and mannitol. Very little acid and no gas from arabinose, starch, pectin, and glycerol.

Acetylmethylcarbinol: Produced.

Citrate: Not utilized.

Temperature: No growth at 45°C on nutrient agar slant. Optimum temperature 35 to 36°C.

Catalase activity: Positive.

Photic characters: None.

Growth at pH 6: No growth.

Coagulated albumen: Proteolyzed.

Cellulose fermentation: Not fermented.

Hydrogen sulfide: Produced.

For the physiological-cultural study, identification, and methods of staining flagella, the Manual of Methods for Pure Culture Study of Bacteria (SAB, 1948), Bergey's Manual of Determinative Bacteriology (Breed et al., 1948), Gray (1926), Leifson (1930), and Maneval (1930) techniques were used as guides.

**DISCUSSION**

A number of bacteria, both aerobic and anaerobic, are involved in the retting of jute. Not all bacteria isolated from retted jute are responsible for the process, as for instance, seven species of aerobic bacteria were isolated from retted jute but only one of them, *B. polymyxa*, was capable of retting jute in laboratory tests. This paper is the first published report that a strain of *B. polymyxa* is capable of retting jute. Because of the important economic considerations of the process, the cultural and physiological characteristics of the strain of *B. polymyxa* found capable of retting jute have been described in detail.

The part played by the other bacteria present on the jute stem in the retting process is not understood. Debsharma (1946) reported that *B. subtilis* retted jute. Neither of the two strains of this bacterium isolated during the present investigation was found capable of retting jute. The lack of activity of the strains isolated in our investigation may be due to the existence of *B. subtilis* in different physiological races. Debsharma also tested *B. cereus* for its retting ability. He found it to be a nonretter. The present investigation confirms Debsharma's report.

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**SUMMARY**

The action of the aerobic bacteria, *Bacillus polymyxa*, *Bacillus subtilis*, *Bacillus cereus*, *Bacillus sphaericus*, *Bacillus lentus*, and *Bacillus pumilus*, on jute stem was studied to detect their retting ability. Only *B. polymyxa* was found to ret jute. The mode of retting is described.
Pectin Decomposition by Species of *Pseudomonas* and Their Role in the Retting of Malvaceous Plants

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Retting, which constitutes a vital step in the production of fibers like hemp, jute, and flax, is essentially a microbial decomposition process and depends upon the property of microorganisms to produce pectic enzymes that decompose pectic substances binding together the fibers. Although considerable information is available regarding the nature and activity of microorganisms involved in retting, (Ruschmann and Baven-damm, 1925a, b; Weizmann and Hellinger, 1940; Ruschmann and Bartram, 1943; Allen, 1944, 1946a, b; Debsharma, 1946; Hellinger, 1953) conspicuously no role, as yet, has been attributed to species of *Pseudomonas* in this process. The purpose of the present study is to report the dominance of *Pseudomonas* species in the retting of certain fiber yielding malvaceous plants and to present chemical evidence in support of the ability of these species to decompose pectin.

In his review on the utilization of pectic substances by microorganisms, Kertesz (1951) has rightly emphasized the need to add to our knowledge concerning the pectin fermenting bacteria which at present is limited and fragmentary. Of the 35 strains of plant pathogenic and fluorescent pseudomonads screened by Oxford (1944), for instance, only 6 strains could degrade pectic acid but the method adopted by him for detecting pectic acid decomposition was crude and qualitative in nature. Barinova's (1946) study, on the other hand, was confined to an analysis for the amount of pectin fermented by *Clostridium felsenium* and *Bacillus acetoe-thylicus* (*Bacillus macerans*). A complicating factor in the evaluation of earlier work in this direction was the impurity (nonpectic substances) contained in the pectic materials used in such work. In many reports, there is no mention of the kind of pectin used. Potter and McCoy (1952, 1955), however, had investigated in detail the fermentation of citrus pectin and pectic acid by *C. felsenium* and *Bacillus polymyxa*, but their report was limited to an investigation of these two bacteria. In the present investigation, we have put to test several isolates of *Pseudomonas* for their ability to ferment pectin *in vitro*. These isolations were made by enrichment culture method from the retted liquors of malvaceous plants.

**Experimental Methods and Results**

**Enrichment and isolation of pectin decomposing bacteria.** *Malachra capitata*, a good substitute for jute (Betrabet and Navalkar, 1956), and *Hibiscus cannabinus* were used for retting. The rettings were carried out both at room temperature (24 to 26°C) and at 37°C. A medium of the following composition in 100 ml distilled water was used: Citrus pectin,¹ 1 g; Na₂HPO₄, 1 Distillation Products Industries, Eastman Organic Chemicals Dept., Rochester, New York.

REFERENCES


